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Measurement of precipitation using lysimeters

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Austria's alpine foothill aquifers contain important drinking water resources, but are also used intensively for agricultural production. These groundwater bodies are generally recharged by infiltrating precipitation. A sustainable water resources management of these aquifers requires quantifying real evapotranspiration (ET), groundwater recharge (GR), precipitation (P) and soil water storage change (ΔS). While GR and ΔS can be directly measured by weighable lysimeters and P by separate precipitation gauges, ET is determined by solving the climatic water balance ET = P GR $\pm$ ΔS.
According to WMO (2008) measurement of rainfall is strongly influenced by precipitation gauge errors. Most significant errors result from wind loss, wetting loss, evaporation loss, and due to in- and out-splashing of water. Measuring errors can be reduced by a larger area of the measuring gauge′s surface and positioning the collecting vessel at ground level.
Modern weighable lysimeters commonly have a surface of 1 m^2, are integrated into their typical surroundings of vegetation cover (to avoid oasis effects) and allow scaling the mass change of monolithic soil columns in high measuring accuracy (0.01 mm water equivalent) and high temporal resolution. Thus, also precipitation can be quantified by measuring the positive mass changes of the lysimeter. According to Meissner et al. (2007) also dew, fog and rime can be determined by means of highly precise weighable lysimeters. Furthermore, measuring precipitation using lysimeters avoid common measuring errors (WMO 2008) at point scale. Though, this method implicates external effects (background noise, influence of vegetation and wind) which affect the mass time series. While the background noise of the weighing is rather well known and can be filtered out of the mass time series, the influence of wind, which blows through the vegetation and affects measured lysimeter mass, cannot be corrected easily since there is no clear relation between wind speeds and the measured outliers of lysimeter mass. Moreover, the influence of wind seems to be varying for different lysimeters.
At the agricultural test site Wagna, Austria, two precipitation gauges in high temporal resolution (weighing-recording gauge and tipping-bucket gauge; both 200 cm^2 surface; measuring height 1.5 m) are installed. Furthermore, mass time series of various lysimeters cultivated with different vegetation is also available for the same location. Appropriate methods to compensate the influence of wind on measuring precipitation using lysimeters are investigated and results between the different measuring devices are compared. Results show that precipitation measured with lysimeters is generally higher, especially compared to the weighing-recording gauge. In addition it is detected that also the data interval of lysimeter mass time series used for quantifying precipitation (e.g., 1 day, 1 hour, 30 minutes, 10 minutes) is a crucial factor and influences the result.
Summarizing, the potential of using highly precise weighable lysimeters for measuring precipitation at the point scale is rather high. However, methods used to compensate external effects on lysimeter weighing have to be enhanced for a global application of using lysimeters as precipitation gauges.

Meissner, R., J. Seeger, H. Rupp, M. Seyfarth & H. Borg, 2007: Measurement of dew, fog, and rime with a high-precision gravitation Lysimeter. J. Plant Nutr. Soil Sci. 2007, 170, p. 335–344.
WMO (World Meteorological Organization), 2008. Guide to Meteorological Instruments and Methods of Observation. WMO-No. 8, 140 pp.